Technical Report 1268
November 1988

# Interference Canceller System (ICS) Test

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## ADMINISTRATIVE INFORMATION

This test was performed by the System Integration and Evaluation Branch, Code 453, Naval Ocean Systems Center, for the Space and Naval Warfare Systems Command, PMA/PMW-159, Washington, DC.

Released by
K.G. Kaufmann, Head
System Integration and
Evaluation Branch


Under authority of
H.F. Wong, Head
Command and Control
Systems Interoperability
Division

JG

# REPORT DOCUMENTATION PAGE

| | |
|---|---|
| 1a. REPORT SECURITY CLASSIFICATION<br>UNCLASSIFIED | 1b. RESTRICTIVE MARKINGS |
| 2a. SECURITY CLASSIFICATION AUTHORITY | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Approved for public release; distribution is unlimited. |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br>NOSC Technical Report 1268 | 5. MONITORING ORGANIZATION REPORT NUMBER(S) |
| 6a. NAME OF PERFORMING ORGANIZATION<br>Naval Ocean Systems Center<br>6b. OFFICE SYMBOL (if applicable)<br>Code 453 | 7a. NAME OF MONITORING ORGANIZATION |
| 6c. ADDRESS (City, State and ZIP Code)<br>San Diego, California 92152-5000 | 7b. ADDRESS (City, State and ZIP Code) |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>Space and Naval Warfare Systems Command<br>8b. OFFICE SYMBOL (if applicable)<br>PMA/PMW-159 | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER |
| 8c. ADDRESS (City, State and ZIP Code)<br>Washington, DC 20363 | 10. SOURCE OF FUNDING NUMBERS<br>PROGRAM ELEMENT NO. 64232N; PROJECT NO. CC54; TASK NO. X1977; AGENCY ACCESSION NO. DN213 105 |

11. TITLE (include Security Classification)
INTERFERENCE CANCELLER SYSTEM (ICS) TEST

12. PERSONAL AUTHOR(S)
S.Y Shih and M.P. Saur

| 13a. TYPE OF REPORT | 13b. TIME COVERED | 14. DATE OF REPORT (Year, Month, Day) | 15. PAGE COUNT |
|---|---|---|---|
| Final | FROM June 1988 TO June 1988 | November 1988 | 20 |

16. SUPPLEMENTARY NOTATION

| 17. COSATI CODES | | | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |
|---|---|---|---|
| FIELD | GROUP | SUB-GROUP | Joint Tactical Information Distribution System (JTIDS)<br>Tactical Air Control and Navigation (TACAN) |
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This document reports the results of the ICS tests conducted the week of 27 June 1988 to evaluate the ability of the ICS to reduce the TACAN power in the JTIDS receive path. Authors recommend that further development be continued on the ICS to avoid saturating the JTIDS receiver.

| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT | 21. ABSTRACT SECURITY CLASSIFICATION | |
|---|---|---|
| ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS | UNCLASSIFIED | |
| 22a. NAME OF RESPONSIBLE PERSON<br>M.P. Saur | 22b. TELEPHONE (include Area Code)<br>(619) 553-8056 | 22c. OFFICE SYMBOL<br>Code 453 |

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# FIGURES

# 1.0 INTRODUCTION

## 1.1 PURPOSE

The purpose of this Interference Canceller System (ICS) Test document is to report the results of the ICS tests conducted during the week of 27 June 1988 at the Naval Ocean Systems Center (NOSC), San Diego, CA. These tests were conducted by David Cooper, Singer Electronics Systems, and observed by Harold Schmidt, Space and Naval Warfare Systems Command.

## 1.2 SCOPE

Singer tested a brassboard ICS at NOSC, Bldg. 410, during the week of 27 June 1988. A prototype Joint Tactical Information Distribution System (JTIDS) ship antenna located under Tactical Air Control And Navigation (TACAN) antenna, the OE-273, and a TACAN URN-25 beacon were provided by NOSC to conduct the tests. The purpose of the ICS is to reduce the antenna coupled TACAN power in the JTIDS receive path while allowing -100 dBm JTIDS signals to be received at 15 MHz or more from the TACAN frequency during TACAN transmissions. The test of 27 June 1988 was only for evaluation of the ability of the ICS to reduce the TACAN power in the JTIDS receive path. The power and signal radiated by the TACAN antenna are not to be effected by the ICS.

## 1.3 AUTHORIZATION

The test was performed on-the-air by authorization of Naval Frequency Coordinator Western U.S., Pt Mugu, CA, on TACAN channel 37X (998 MHz). The tests were coordinated with the Federal Aviation Administration (FAA). The authorization is shown in appendix A.

## 1.4 REFERENCES



### 1.4.1 TACAN Interference Canceller

Preliminary Test Plan, 31 March 1988
by Dr. David Cooper
Singer Electronic Systems Division
Wayne, NJ 07470

### 1.4.2 F-14D Interference Cancellation System

TACAN Interference Cancellation System
Preliminary Design Review, 29 September 1987
by Dr. David Cooper
Singer Electronic Systems Division
Wayne, NJ 07470

# 2.0 TEST INSTALLATION

## 2.1 TEST FACILITY

The Test Facility consists of a TACAN antenna (OE-273) with lightning arrester mounted above a prototype JTIDS antenna, mounted on a 25-foot mast. The TACAN antenna, TACAN RF cable (150 feet), and associated control cables are connected in Bldg. 410 via an underground 4-inch PVC pipe. The JTIDS RF cable (150 feet) is laid out above ground and terminates within Bldg. 410. Both ends of the DELAY RF cable (300 feet) terminate within Bldg. 410. The TACAN beacon (URN-25), control indicator, AC power, DC power supplies, and test equipment are all located within Bldg. 410. The test facility is depicted in figure 1.

## 2.2 RF TEST CABLE CHARACTERISTICS

The following RF cables were used for the 27 June 1988 tests at the test facility:

LDF-50 Cable; Delay (RF) = 300 feet
Return Loss vs Frequency @998 MHz = app. 26 dB
Insertion Loss vs Frequency @998 MHz = app. 11 dB

LDF-50 Cable; TACAN (RF) = 150 feet
Return Loss vs Frequency @998 MHz = not measured
Insertion Loss vs Frequency @998 MHz = not measured

connected in series with the

LDF-50 Cable; Delay (RF) (300 feet) = 450 feet
Return Loss vs Frequency @998 MHz = app. 35 dB
Insertion Loss vs Frequency @998 MHz = app. 17 dB

LDF-50 Cable; JTIDS (RF) = 150 feet
Return Loss vs Frequency = not measured
Insertion Loss vs Frequency = not measured

## 2.3 TACAN OPERATION

The URN-25 TACAN was satisfactorily checked and tested by the Naval Electronics Systems Engineering Center, Vallejo, CA. The URN-25 TACAN Reference Standard Sheet comprises a front panel power and current readings. Additionally, output pulse shapes were measured using an oscilloscope. The Reference Standard Sheet is shown in appendix B.

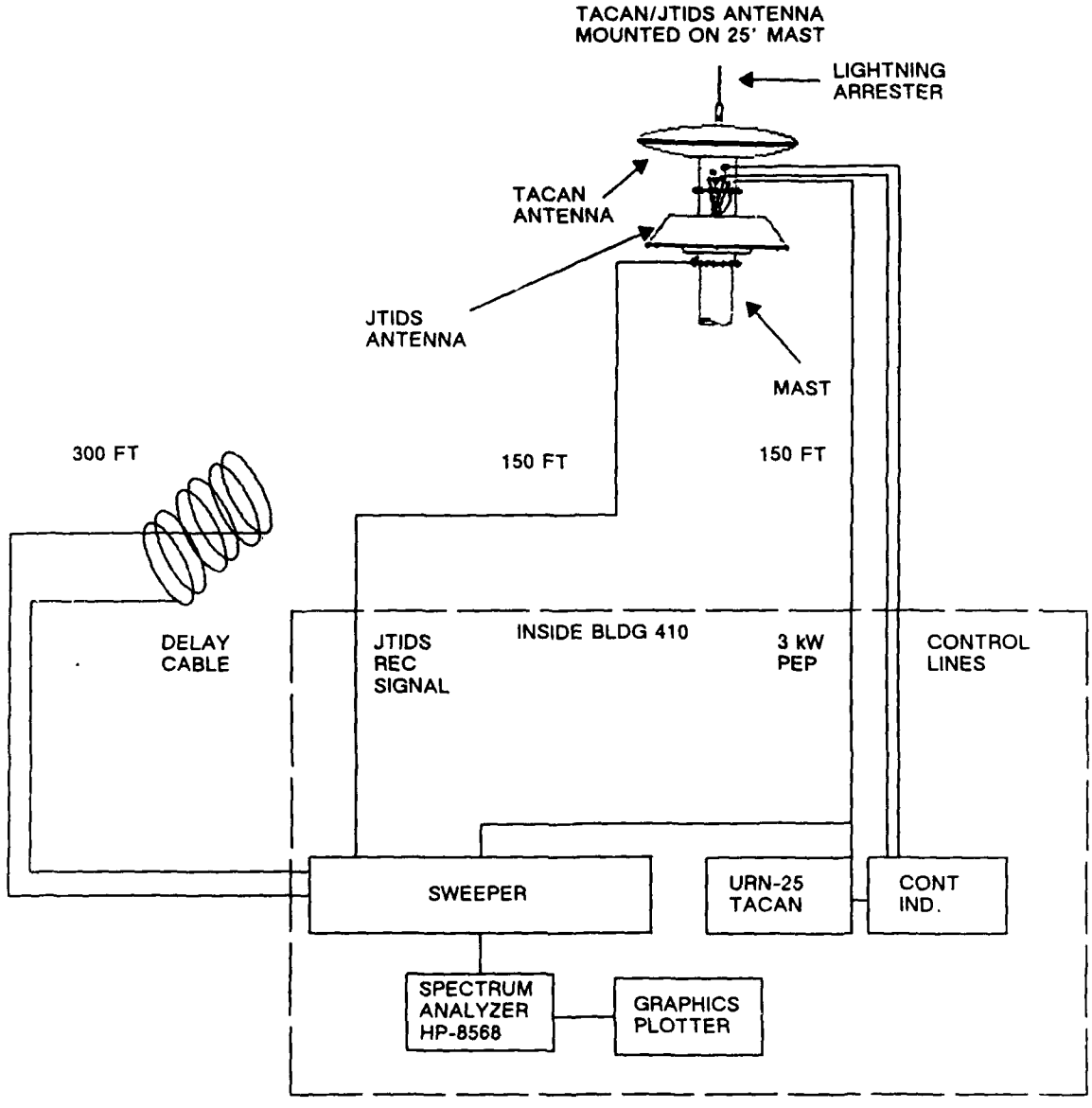


**Figure 1.** Test facility.

# 3.0 ICS TEST EVALUATIONS, OBJECTIVES, RESULTS, AND CONFIGURATIONS

## 3.1 TEST #1 - DELAY AND COUPLING

### 3.1.1 Delay and Coupling Evaluation

The evaluation of delay, multipath, and isolation between the TACAN and JTIDS antennae gives the optimum delay line length required to effect maximum signal cancelling at the input of the JTIDS receiver port.

### 3.1.2 Delay and Coupling Objective

The objective of this test is to determine the optimum length of delay line for the ICS to cancel the TACAN signal when received by the JTIDS receiver.

### 3.1.3 Delay and Coupling Result

These tests showed that a 300-foot cable in series with the ICS provided maximum isolation between TACAN signal and JTIDS receiver port.

### 3.1.4 Delay and Coupling Configuration

The configuration of ICS test #1 is depicted in figure 2.

## 3.2 TEST #2 - CANCELLER PERFORMANCE USING A LOW-POWER PROBE SIGNAL

### 3.2.1 Canceller Performance Evaluation

This test measures the ability of the interference canceller to reduce interference between the TACAN antenna and JTIDS receiver. Time delay, approximately equivalent to the length of the TACAN and JTIDS RF path (300 feet), was inserted in series with the ICS weight. The signal generator (continuous wave (CW) signal) was swept over a 20-MHz spectrum, the weight held constant after tuning to a single frequency, and level measurements were made with the canceller both in and out of the circuit.

### 3.2.2 Canceller Performance Objective

The objective of this test is to produce a minimum cancellation of 30 dB, while sweeping across a 20-MHz bandwidth frequency.

### 3.2.3 Canceller Performance Results

The results of these tests proved that the ICS could cancel the CW signal generator more than the required 30-dB objective. However, this is only after manually tuning the weight to the desired frequency.

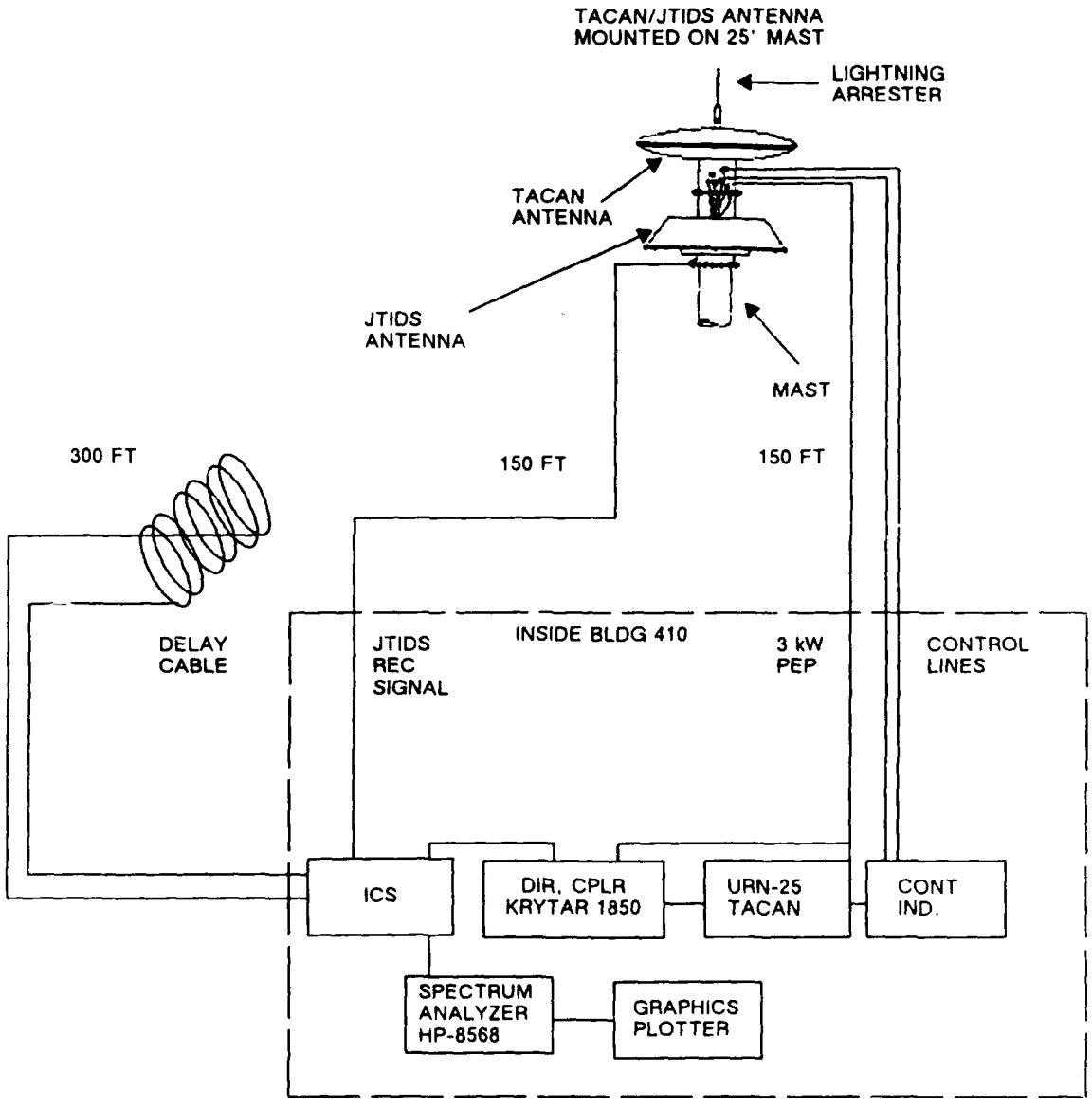


**Figure 2.** ICS test #1 configuration.

### 3.2.4 Canceller Performance Configuration

The configuration of ICS test #2 is depicted in figure 3.

## 3.3 TEST #3 - CANCELLER PERFORMANCE USING A URN-25 TACAN SIGNAL

### 3.3.1 Canceller Performance Evaluation

This test measures the ability of the interference canceller to reduce interference between the TACAN antenna and the JTIDS receiver port. Time delay, approximately equivalent to the length of the TACAN and JTIDS RF path (300 feet), was inserted in series with the ICS weight. Instead of an unmodulated CW signal, a fully modulated CW TACAN signal is used in lieu of the signal generator.

### 3.3.2 Canceller Performance Objective

The objective of this test is to produce a cancellation of 40 dB, resulting in −15 dBm TACAN interference signal at the JTIDS receiver port. The JTIDS receiver nonlinear region is between 0 dBm to −10 dBm. To avoid saturating the JTIDS receiver, it is required that the TACAN signal at the JTIDS receiver be −15 dBm. The URN-25 TACAN radiates 3 kW in the high-power mode, which is +65 dBm. Assuming 40 dB isolation between the TACAN and the JTIDS antenna, the JTIDS would receive +25 dBm at the front end. To achieve the −15 dBm at the JTIDS receiver, a cancellation of (+15+25) dB = +40 is required.

### 3.3.3 Canceller Performance Results

The testing started on 27 June 1988 without any attenuation being inserted in series with the ICS. The result was a 20-dB cancellation, 15 dB less than the expected 35 dB, as depicted in figure 4. The reason for these poor results is due to the inability of the ICS to respond quickly enough to the modulated TACAN signal. Additionally, it is felt that the components within the ICS cannot sustain the high power (3 kW) signal from the TACAN. After various amounts of attenuation were inserted in series with the ICS, the optimum result of these tests produced a 30-dB average cancellation at the designated frequency; 25 dB average, 3 MHz on either side of the designated frequency; and 25 dB average, 6 MHz on either side of the designated frequency. These tests were all conducted at the "fixed" test frequency of 998 MHz (channel 37X), with the ICS in the manually tuned mode of operation. These results are depicted in figure 5.

### 3.3.4 Canceller Performance Configuration

The configuration of ICS test #3 is depicted in figure 6.

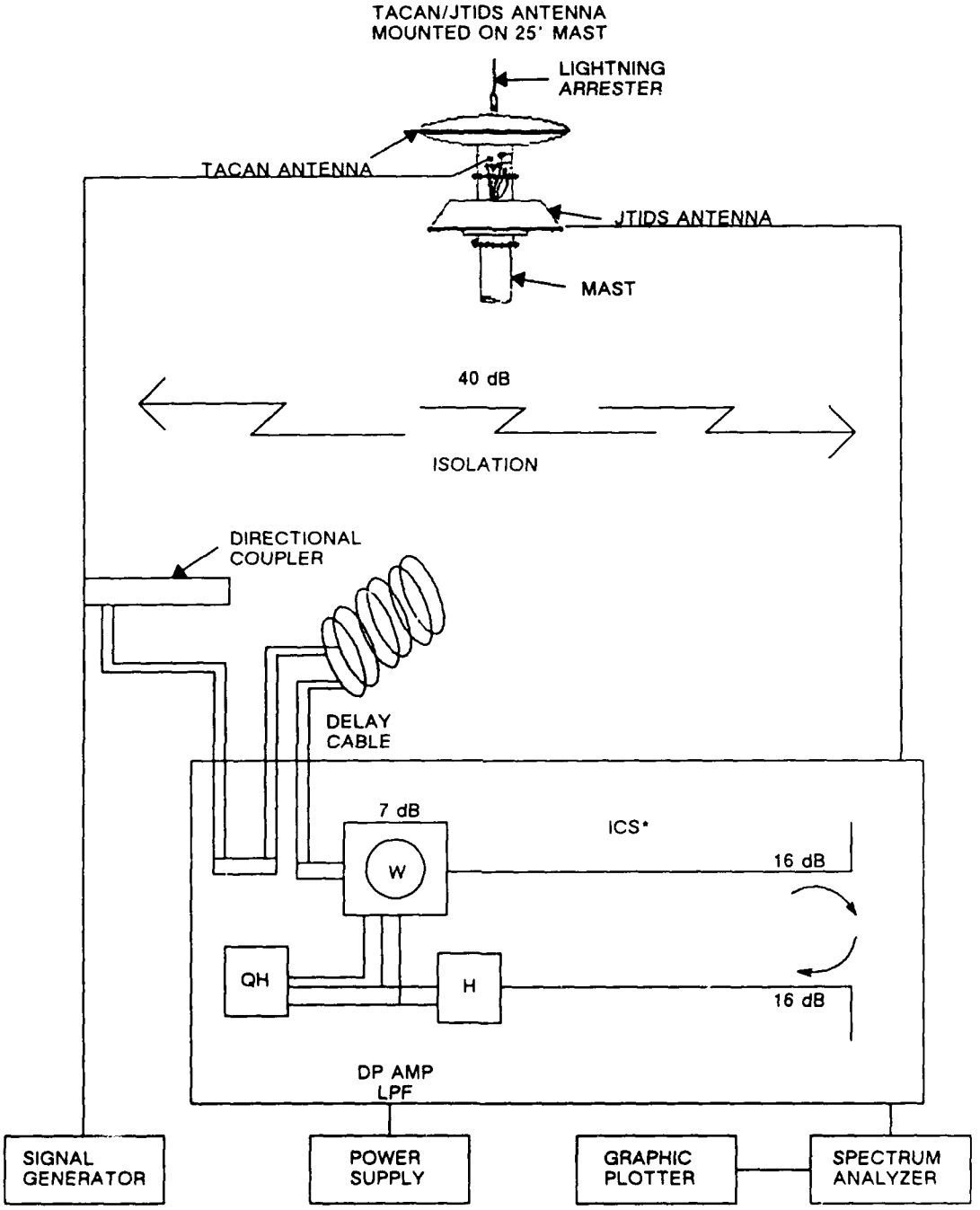


**Figure 3.** ICS test #2 configuration.

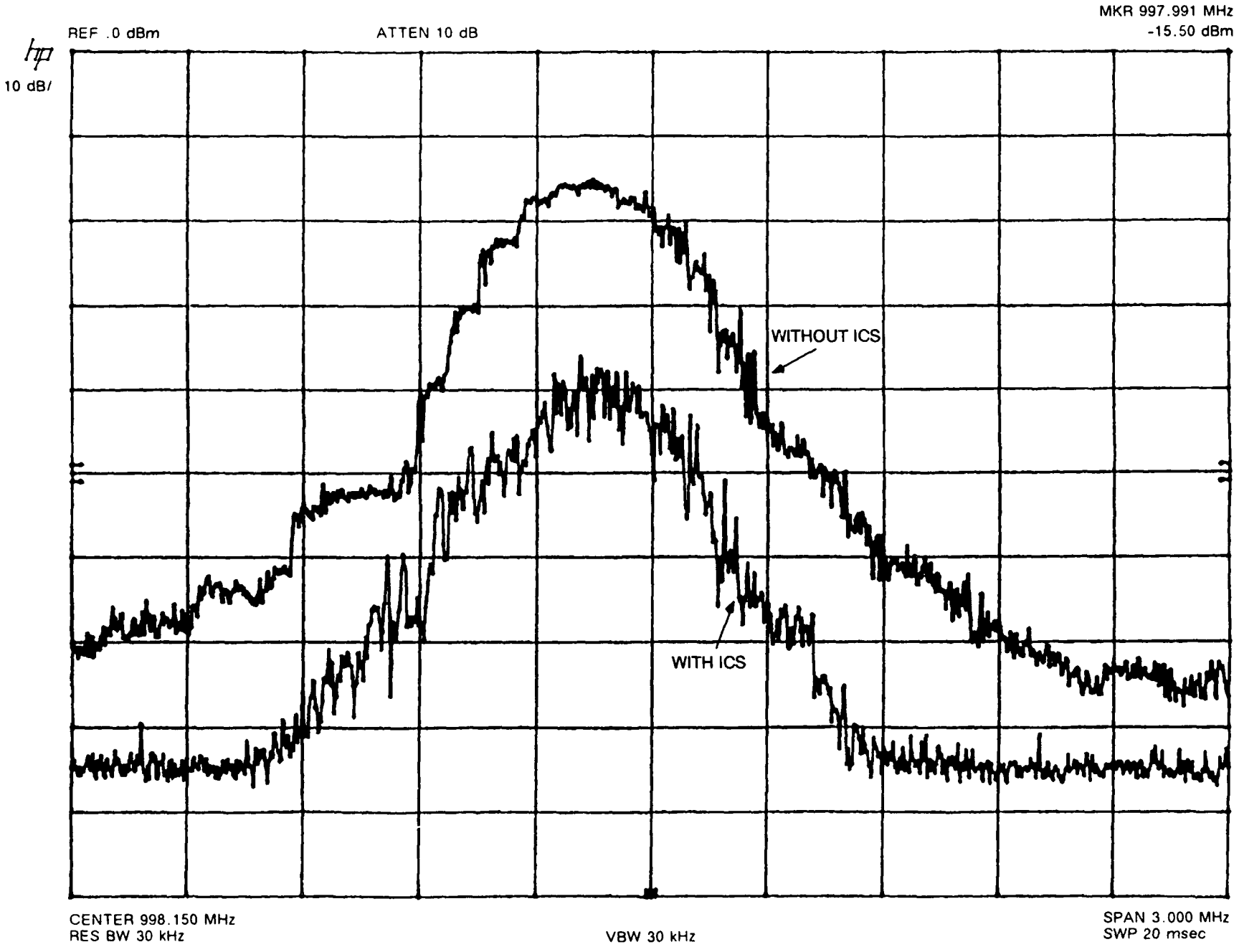


**Figure 4.** ICS test #3 finding.

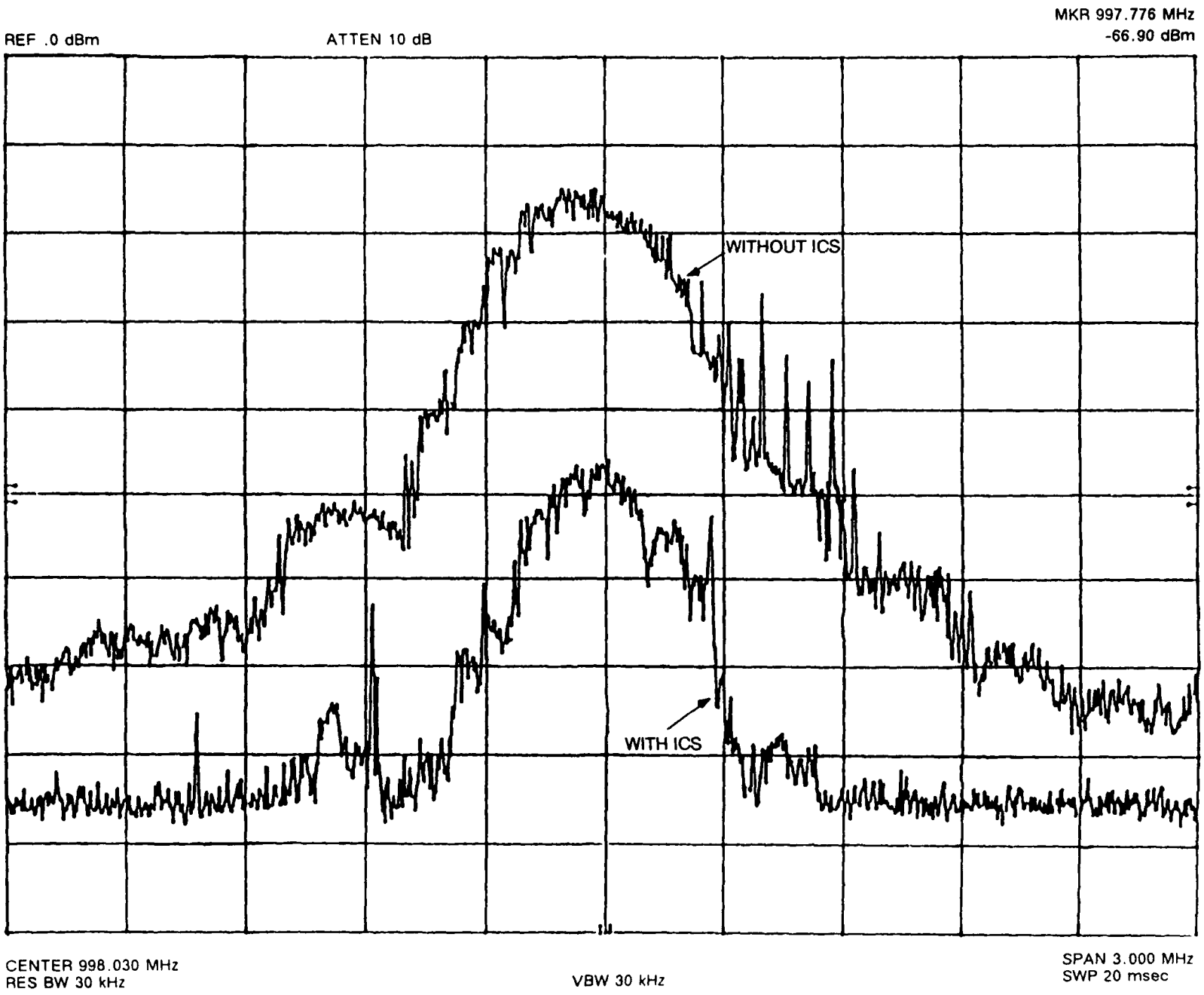


**Figure 5**. ICS test #3 result.

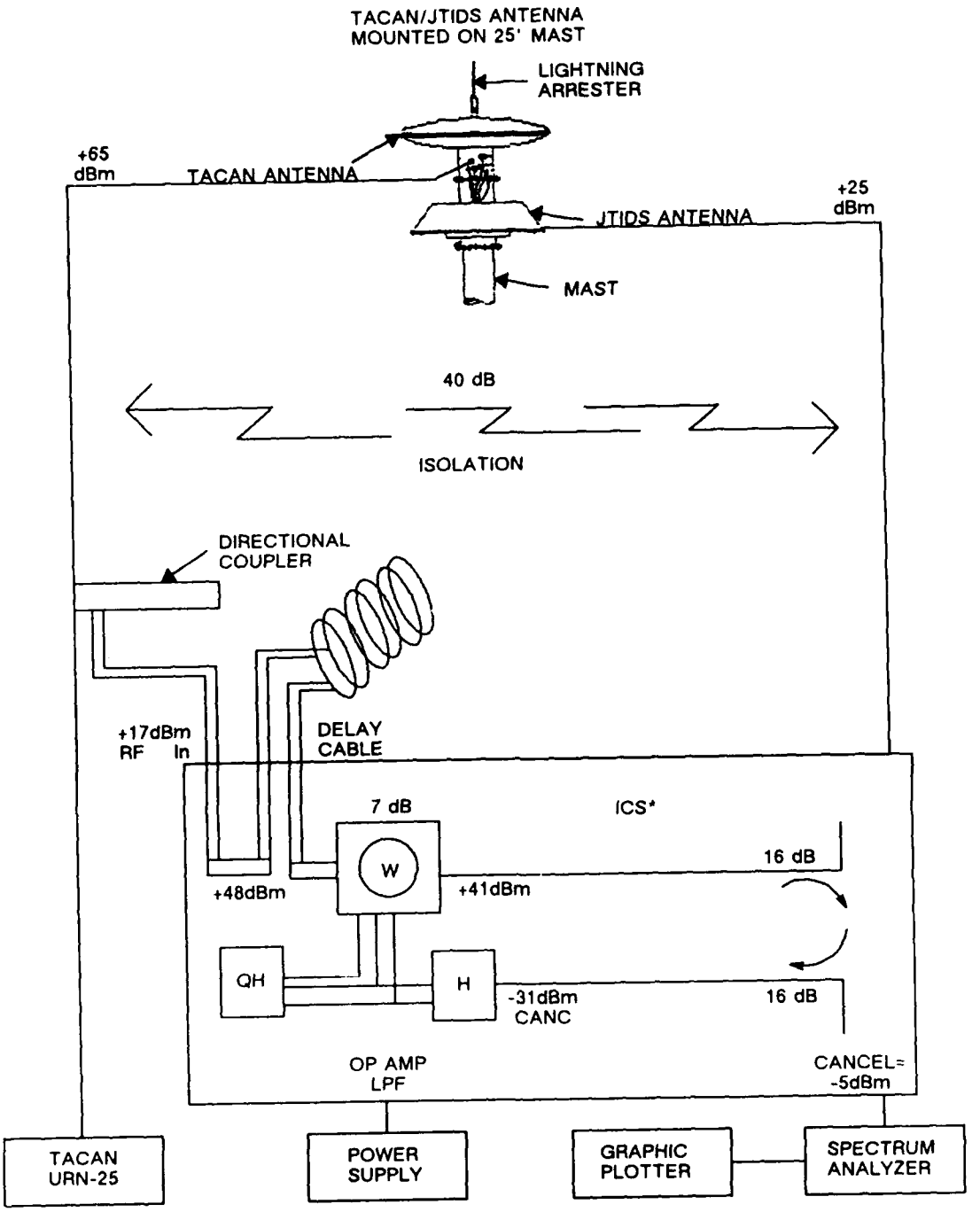


**Figure 6.** ICS test #3 configuration.

# 4.0 RECOMMENDATIONS

## 4.1 INTERFACE CANCELLER SYSTEM

The ICS tested satisfactorily for test #2, in a fixed frequency, CW mode of operation, after fine tuning the weight. The weight requires fine tuning each time the frequency is changed. This ICS test model was only tested to determine the cancelling capability, while the automatic fine tuning version is still undergoing final developments. Additionally, the ICS requires the delay circuitry internal to the ICS module to preclude the requirement of a 300-foot-long piece of LDF-50 RF cabling to allow maximum cancellation of the TACAN radiated signal. It is, therefore, recommended that the ICS be fitted with the delay, attenuation, and automatic frequency tuning capabilities prior to further testing using the URN-25 TACAN and the frequency allocation resources required for going on the air.

During ICS test #3, with a modulated CW TACAN signal, the ICS failed to achieve the required 30 dBm of cancellation as per the objective. It is felt that this phase of testing can be done in a laboratory environment using a modulated CW signal rather than an operating, on-the-air, TACAN system requiring FAA and area frequency coordinator authorization.

The ICS has not shown that it can receive a JTIDS signal at –95 dBm either at 15 or 100 MHz away while a TACAN is transmitting.

Given these test results and the progress to date, it is recommended that further development be continued on the ICS to avoid saturating the JTIDS receiver.

# APPENDIX A

## NAVFRCOORD Western US MSG 131515Z Jun 88

ADMINISTRATIVE MESSAGE

ROUTINE

R 131515Z JUN 88 ZYB PSN 838336531

FM NAVFRCOORD WESTERN US PT MUGU CA

TO NAVOCEANSYSCEN SAN DIEGO CA

INFO FAA WESTERN RGN HQ LOS ANGELES CA//AWP-496//
NAVCAMS EASTPAC HONOLULU HI NAVFRCOORD NAVCOMMSTA SAN DIEGO CA
CINCPACFLT PEARL HARBOR HI

UNCLAS //N02410//

SUBJ: TEMPORARY FREQUENCY ASSIGNMENT-USN

A. NAVOCEANSYSCEN SAN DIEGO CA//272032Z APR 88
B. FONECON BTWN MR. FREITAS(FAA)/TURKIEWICZ(WAFC) 06/10/88.

1. TACAN CHANNEL 37 (998 MHZ) IS AUTHORIZED FOR YOUR USE 06/27/88 - 07/01/88 TO SATISFY REF A.

2. COORDINATION EFFECTED FAA (REF B)

BT

DLVR: NAVOCEANSYSCEN SAN DIEGO CA(1)...ACT
TCO(1)...INFO FOR NAVCOMMSTA SAN DIEGO(5) 15785/ 3/0100
CWO(1) CAT(1) NSGD(2)

RTO: 000-000/COPIES: 0006

838336/166 01 OF 01 NRAD1664 166/20:49Z 131515Z JUN 88
CSN: RXPA00246 ENCLOSURE 1 166/20:49Z NAVFRCOORD WES

# APPENDIX B

## URN-25 TACAN Reference Standard Sheet

REFERENCE STANDARD
FOR
AN/URN-25 TACAN

OUTPUT POWER

PA-----3000 WATTS
IPA----876 WATTS
SSD----69 WATTS
REF----40 WATTS
MED PA-746 WATTS

OUTPUT CURRENT

PA-----87 mAMPS
IPA----32 mAMPS

OUTPUT PULSE SHAPE

AMPLITUDE-----6.2 VOLTS
LEADING EDGE--2.8 mmSEC
TRAILING EDGE-2.8 mmSEC
PULSE WIDTH---3.3 mmSEC

REFERENCE STANDARD COMPLETED by:

Thomas C Brown
Tom Brown
NAVELEXSYSENGCEN VJO
DATE 22 June 88

ACCEPTED by:

MP Saur
NOSC San Diego
DATE 22 JUN 88